Are the Brazilian municipalities investing oil revenues in human capital?

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Abstract:

This paper assesses the effect of oil revenues on health and education indicators (measures for human capital) in the Brazilian municipalities using exogenous oil price variations. The Oil Law of 1997, apart from to hugely increase the amount of oil revenues distributed to the eligible municipalities due to the withdraw of the internal control price system, broadened its possible uses by the eligible municipalities, including investments in health and education in addition to traditional investments in infrastructure. Since Brazil has decentralized primary education and primary health care provision to the municipalities, we use the oil price as an external intervention to the local economies to identify the effect of the non-renewed natural resources in promoting sustainable growth. We also explore the high inequality in oil revenues distribution among municipalities. Similar to the previous literature, our results point to a small improvement of the human capital indicators in the long run. The contribution of the largest oil revenue recipients, however, is null for these indicators.

Keywords: oil revenue, health, education, inequality, natural resources

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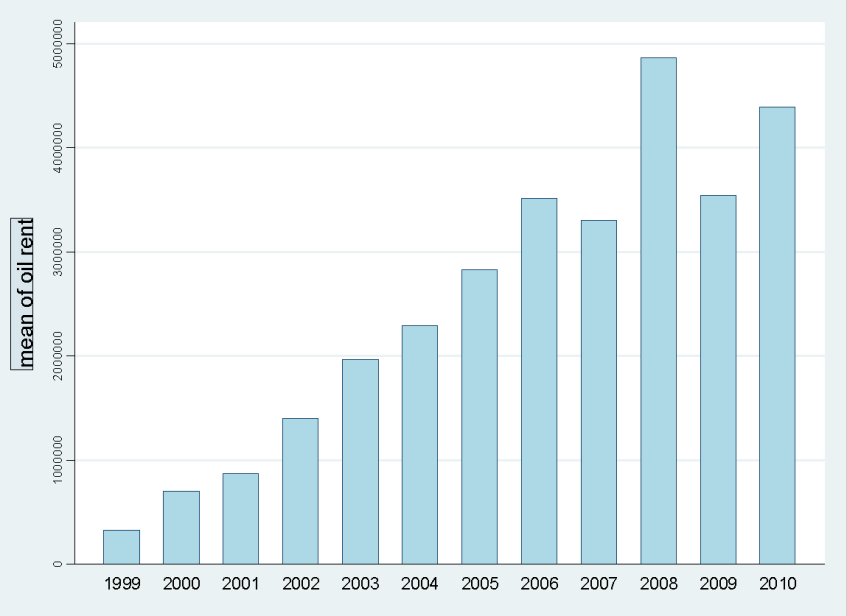
1. Introduction

The quality and quantity of human capital is considered an essential condition for economic growth (Benhabib and Spiegel 1994). Thus, this paper assesses whether the Brazilian oil revenues, shared in accordance with the Petroleum Law (Act 9478/97) of 1997, have a positive effect on a set of schooling and health indicators of the benefitting localities. We use these indicators as proxies for human capital - the level of knowledge, habits, social and personality attributes, as well as health of the inhabitants - because human capital is not directly observable. Becker (1993) points education as a natural investment for human capital. Grossman (2000) argues that health can be seen as a durable human capital stock that requires investments to increase and that depreciates with age.

The Oil Act of 1997 resulted in a remarkable increase in the budgets of several municipalities and states after 1999, because it changed the methodology employed for measuring the oil revenues of each eligible municipality. Additionally, changes occurred in exchange rate policy after 1999 to a floating model, combined with a huge rise in international oil prices after 2000 that lasts until 2014. The Law eliminated the price controls that kept the Brazilian domestic price artificially below the international standards. In addition, the royalty-rate was set at 10% of the gross value of production against 5% before 1997. Figure 1 shows the rise in oil revenues paid to the eligible municipalities since 1999.

Figure 1 – Annual distribution of oil revenues paid to the eligible municipalities in thousands of Reais



Source: authors from ANP data

After the Oil Act of 1997, a group of municipalities obtained significant amounts of oil revenue (see Figure 2 for the receiving municipalities in 2010). Part of the eligible municipalities had already received oil revenue before 1997, but in much smaller amounts. Other new recipient municipalities started receiving oil revenues after the new law through out the decade. The petroleum rent in Brazil splits between municipalities designated as a 'producing locality', and municipalities directly or indirectly affected by oil and gas upstream activities.

The Act sets out four ways that local governments can obtain income from the production of oil, but royalties are the main source.[1] The payment of royalties is a tax of 10% on the gross national production of oil. As the law eliminated domestic artificial oil price, the international oil price became an exogenous variable for the Brazilian economy and we use it as a natural experiment to address the oil revenues effects on human capital indicators. Moreover, the law increased the number of municipalities eligible to receive these funds through the time, despite the greatest recipients concentrates almost all the oil revenues, Table A1. Using municipal data observed

[1] The payment of royalties and occupation rates is mandatory in every lease contract. Details about each tax are outlined in Presidential Decree 2.705/1998.

annually from 2000 to 2010, we have information of municipalities that were receiving royalties in 2010 and new other staring receiving after.

The great change of the Oil Law of 1997, as compared to the previous law number 2004 of 1953, regarding oil rent uses, was to broaden the scope of alternatives uses by the eligible municipalities to include investment in health and education. According to the 1953 law, these resources must be invested in physical capital/infrastructure (energy, sanitation and environmental services), whereas the new law just prohibits using these revenues in current expenses. In this sense the new law includes investment in health and education as a possible type of investment in addition to the physical capital investment as mandatory use for this revenues.

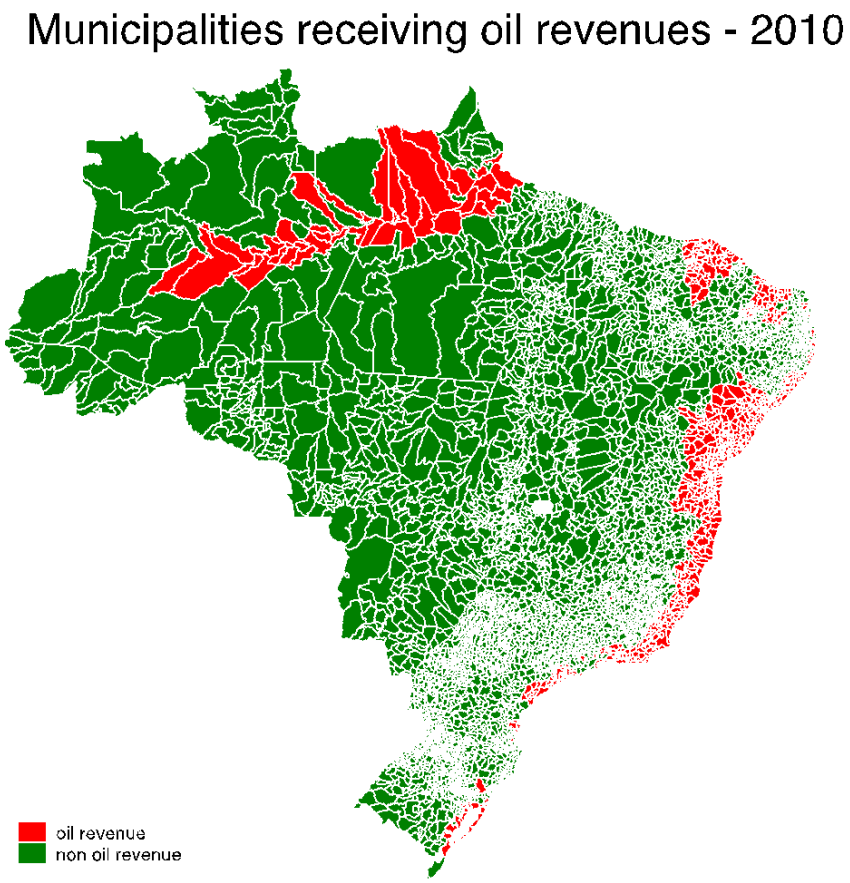


Figure 2 – Municipalities receiving oil revenues

The Brazilian public primary school and primary public health system (the SUS) has been decentralized to the municipalities after 1998, when the Brazilian Constitution was enacted. This legal framework allows us to evaluate the local financial decisions

regarding different choices of investment using oil rent. However, we need to control for the decentralization process on going to identify the effect of oil rent on the indicators. The financial decentralization is still underway, municipalities are in charge of financing education and health with at least 30% of its own resources (taxes and transfers) for each area, 15% for education and 15% for health, but they are not able to full finance themselves. In the first case the law 97 of 1996 determined it and the latter was set after 2000 when the Amendment 29 enforced the municipalities to finance part of their health expenditures. Regarding management decentralization, the municipalities almost finished the process at the end of the first decade of XXI century, thus they delivery primary education and health to the local population in a great proportion.

As mentioned above, the economic growth literature has pointed out the importance of human capital investments in addition to and physical capital investment to explain sustainable growth (Benhabib and Spiegel 1994; Kumar 2017). Thus, if the Brazilian municipalities invest their oil revenues in health and education (human capital) this could improve the local economy.

The rationality behind the Act can be understood based on the Hartwick's rule. According to this rule, revenue from non-renewable natural resources must be invested rather than spent on consumption in order to avoid welfare losses for future generations. This revenue is the user cost, the difference between the market price of a resource and its marginal cost of extraction. The 'user cost' is a temporal opportunity cost.

A country is able to maintain a constant rate of consumption per capita indefinitely as long as it invests a proportion of its mineral rent in physical and human capital (Hartwick, 1977). The non-renewable resources are assets that depreciate as they are depleted. In a dynamic equilibrium, the value of finite resources is the sum of its discounted net returns, or the present value of their user costs. The reduction in the amount of capital when the resource is exhausted, which corresponds to the production value, is defined as the Hotelling rent (Hotelling, 1931).

In order to sustain a certain level of consumption per capita at the steady state, the Hotelling Rent must be invested to diversify the economy (Hartwick, 1977 and Sollow, 1974). This investment should offset the country's depletion of its natural capital.

Then, the Brazilian central government provides a percentage of oil revenue (royalties) to the municipalities affected negatively by its production as financial

compensation. The central government, as the owner of all natural resources, both onshore and offshore, invest it in maintaining the social welfare system. Investment in human capital is one of the alternatives open to municipalities after the 1997 law, but they can invest alternatively in physical capital, particularly in infrastructure.

We suppose more revenues available to be invested in human capital or physical capital must result in; i) better schooling and health indicators if a municipality invests it in human capital, ii) no changes in schooling and health indicators if the local government invest it only in physical capital; and iii) no changes if the extra it is not invested.

Postali and Nishijima (2013), using data from the National Censuses of 1991, 2000 and 2010, show that, in the long run, as a result of oil royalties, eligible municipalities in Brazil were able to improve physical capital as measured by the household's access to electric wiring, piped water and garbage collection indicators. They also got a statically significant effect for illiteracy rate. However, there is still a lack of information about investment in human capital, mainly because the effects on physical capital are not big in the long run.

This study has particular relevance for Brazil, because there is a recent discussion about changing the criteria that governs the division of oil revenue between the municipalities. The criteria are very controversial and some groups are lobbying for a proposition to distribute oil rents more equally. The current rules are designed to benefit a restricted group of municipalities at the expense of the vast majority, according to Serra (2003). The largest amount of royalties is paid to municipalities that are designated as producers. When the oil being exploited is offshore, the question of whether a municipality is eligible as a producer is determined by the projection of its geographical contours on the coastline. The revenue from royalties is proportional to the production figures of the wells within this area. Thus, depending on the shape of its coastline, the municipality may have more or fewer wells within its area of entitlement and be granted royalty payments accordingly. On the other hand, there is a lack of discussion about the manageable channels that could effectively improve the local welfare using oil revenues that can be based on impact evaluation studies.

Some studies investigate the relationship between the royalties received and the region's degree of social development. However, Van der Ploeg (2011)'s survey shows that having natural resources can be good or bad for a country, according to its

institutions' quality, democracy status, and the traditional explanation of exchange rate channel (Dutch disease). Also, the author's findings suggest developing countries, which are rich in natural resources, fail at converting their depleting exhaustible resources into other types of productive assets.

Papyrakis and Gerlagh (2007) show a negative correlation between the abundance of natural resources and growth for some regions in the United States. They find decreases in investment, schooling, commercial trading, and RandD expenditure and increases corruption as a consequence of the abundance of natural resources on growth.

Regarding Brazil's use of oil rent, the majority of studies point to no effects on human stock of capital, though almost all of them show significant increases in the budget of education and health areas. But these studies, with few exceptions, use data right after the Oil law was enacted, when the oil revenues were not so high. Other common characteristics is that some of them evaluate only the big eligible municipalities, see the appendix, since there is a huge inequality in oil rent distribution among the municipalities; probably the greatest receptors will have more significant results.

Caselli and Michael (2013) study the effects of royalties on budgetary behavior using the Brazilian municipal data. Regarding the fiscal area, they conclude that revenue windfall taxes lead to a corresponding increase in the reported spending in certain areas (such as urban infrastructure, education and health). On the other hand, socio-economic factors, including education and health, are not affected by the increase in oil revenues. The results of this study, however, are restricted to the short term. The authors use data from the Brazilian Census for the year 2000, a period very soon after 1997, when the scheme for supplying municipalities with oil revenues was first implemented, with the enacting of the New Petroleum Law.

Costa Nova (2005) examines several social indicators of some important beneficiaries in the state of Bahia and concludes that these municipalities had not improved their social indicators significantly and were not much above the regional average, despite the surplus in their municipal budgets resulting from extra funds from royalty payments.

In his investigation of public investment, Bregman (2007) studies the relationship between capital expenditure, levels of investment and the degree of dependence on oil revenues from 1999 to 2005. By grouping 871 eligible municipalities according to the share of royalties in their annual budgets (and thus measuring their degree of dependence on oil revenues), this author provides an estimate of a pooled regression, and concludes that the most royalty-dependent municipalities had increased their capital expenditure accordingly.

Fernandes (2007) examines the impact of oil revenues on the economic development of Rio de Janeiro, the largest beneficiary state, by comparing the indicators of the municipalities in the main production area of the Campos Basin with those of the municipalities bordering the zones of production. The author notes that there was a greater relative impact of royalties on social spending, including education, cultural activities, health and sanitation and on investments per capita. He concludes that oil resources are a valuable means of funding the social services of these municipalities.

Givisiez and Oliveira (2008) investigate whether oil royalties have had an impact on the educational indicators of the major recipients among Rio de Janeiro's municipalities, compared to similar localities within the same state. In sharp contrast with Fernandes, they conclude (on the basis of data from 2005), that there is no evidence of a causal effect in this area.

Postali and Nishijima (2011) evaluate whether oil windfall revenues had an impact on aggregated social indicators of health, education and employment from 2000 to 2007. Results suggest significant effects of oil rents only on employment.

The studies analyzed above provide inconclusive results for determining the effects of oil revenue on social indicators. However, on the basis of the analysis conducted, it is possible to discern positive results that occur over the long run. The studies that find no positive effects on social indicators were conducted during a short or medium period, usually before 2005. These findings suggest that there is a need to measure the effects of oil revenue in terms of a longer time period, as it is likely that the human capital effects will only become apparent over the long term.

2. The provision of basic schooling and primary health care in Brazil

To some extent, the 'human capital' of a nation depends on its institutional design. Thus it is worth briefly examining the public schooling system and the public health system in Brazil, as well as the policy interventions in these areas. This knowledge can enable us to have a better understanding of how the extra revenue from oil can affect the health indicators and thus find a suitable way to control for other determinants.

According to the Federal Constitution, in 1988, all schooling and health services must be provided for free by local governments to all Brazilian citizens. Since that time, the schooling and health care administrative decentralization process has gradually improved and has accelerated in the last decade with programs of primary health care. In particular the municipalities are in charge of the universal primary education (elementary and middle school) and the primary health care services (prevention and outpatient treatments).

Regarding the decentralization of primary education, the FUNDEF (Fundo de Manutenção e Desenvolvimento do Ensino Fundamental e da Valorização do Magistério) law number 9,424 of 1997 started the process, creating a budget and transfer mechanisms from the central and states' government to the municipalities. At that time, the central government, in charge for planning and managing the decentralization, define that states and municipalities must finance schooling with a minimum of 15% of their own resources (taxes and transfers) invested in this area. The education decentralization process comes through the 2010 decade. The municipalities are responsible for primary education – preschool, elementary school and middle school – and states became responsible for higher education. In the beginning, high-school was under the state's provision and after 2010 it started to change to the municipalities provision.

The 59 Amendment of 2008 widened the compulsory education from 6-15 years old to 4-17 years old, but the municipalities are obligated to finish it in 2016.

Regarding health decentralization, the local provision can be evaluated by the Family Health Program (PSF) evolution. PSF is the main gateway for the population to have access to the SUS.

Similar to the basic education system to provide free access to schooling, the Brazilian public health system, the SUS, (Unified Health System) grants full access to

all health services. The general guidelines of SUS encourage decentralization,[2] preventive measures and social participation. In its organization, municipalities must provide primary healthcare while the state governments provide more complex health services and they must share the responsibility for delivering health services. The central (federal) government lays down the health policy guidelines and transfers funds to the states and municipalities for the implementation of the policies.

However, regarding health resources, the Constitution of 1988 did not stipulate that local governments were responsible for funding these services. The incentives for local governments to finance their own health expenditures have been defined over time and there has been a gradual decentralization of financial responsibilities. It was only as a result of Amendment 29 of 2000 that the financing of health services began to be decentralized. This guides our sample definition, because of that we use data from to 2000 to 2010.

There are transfers of funds from the federal government to municipalities to finance health and the revenue from oil may be used to finance additional spending on health investments. The eligible municipalities choose how they wish to spend the oil revenue from among several different investments in physical or human capital.

Simultaneously to the administrative decentralization, the widening access to the public health system was a consequence in Brazil. It was only after 2000 that the Family Health Program (PSF) began to spread throughout the country (Viana and Dal Poz 2005). However, in some places there is still a lack of full coverage, which means effective decentralization is very recent.

Most of the schooling and health indicators in Brazil have improved since the Constitution of 1988 as a result of several programs and policy interventions. For example, the Bolsa Familia (BF) cash transfer program widened the population access exponentially after 2004 to public health system and public primary education. To receive BF cash transfers the family must to enroll children at school and register them at PSF. Regarding health care, there is evidence to show that PSF improved health in Brazil, at least in the early years of its implementation (Macinko and Guanais, 2009; Rocha and Soares, 2010; Rocha et al., 2013).

[2] It can be said that Brazilian Constitution is in accordance with or complies with the basic principles of the Oates´ Decentralization Theorem (1999).

Thus, the main difficulty is to determine which part of the recent trend in education and health can be attributed to a specific measure or policy, in our case oil revenues, because our data go to 2000 until 2010. Our task is to detach the effect of this revenue on health and schooling indicators from other factors and changes in public health and education programs. To achieve this, we need to control our estimates for policies such as the PSF program and Amendment 59 in order to avoid biases.

3. Data and Methodological Strategy

As the Court of Auditors stipulates that municipalities must invest these payments, and the scope of investments has been significantly enlarged, the fundamental question is whether these resources have led to any social returns in terms of human capital improvement to the municipalities that receive the benefit.

We suppose that an eligible municipality can invest its extra revenues in education or in health capital or not. If it invests in human capital, then the education and health conditions must improve (being the municipality less or more efficient). On the other hand, if it doesn't, no effect is expected for these conditions.

By using municipal panel data from 2000 to 2010, we assess the effect of oil revenue on the human capital, the municipal education or health indicator, I_i. To evaluate it we apply a Difference in Differences (DD) model with multiple time of intervention to evaluate the effect of the oil revenues on the education and on the health sector according to the literature of 'treatment models' for policies and programs (Lee, 2005) and as proposed by Imbens and Wooldridge (2009). Since the major part of oil revenues municipalities' recipients, 738, already received it in 2000, and only a few municipalities started receiving revenues after 2000 until 2010, 152 new, we use the oil price as a shock variable to identify the oil revenue effect on the indicators. In view of the fact that oil price is not affected by the oil Brazilian production, it can be treated as exogenous to education and health indicators, our proxies for human capital.

We use data from different sources to compose our panel of municipal information, as can be seen in Table 4.1, which is composed of all the 5560 Brazilian municipalities. All the data are used in logarithm form, except variables with values ranging from 0 to 1.

Table 4.1 – Data Description of Data and Source

Descrition	Source
logarithm of infant undernourishment rate (number of children undernourished up to 1 year old/number of children up to 1 year old)*10,000	DATASUS
logarithm of infant mortality rate: (rate of infant mortality up to 1 year old/number of children up to 1 year old)*10,000	DATASUS
logarithm of cases of malaria (number of cases of malaria/population)*10,000	DATASUS
logarithm of new cases of HIV/AIDS: (number of new cases of HIV/population)*10,000	DATASUS
logarithm of cases of dengue: (number of cases of dengue/population)*10,000	DATASUS
Number of vaccinated children per number of children under 1 year old;	DATASUS
Number of vaccinated children per number of children under 2 years old;	DATASUS
Number of pre-natal appointments per number of pregnancies	DATASUS
Number of people with monitored diabetes per number of diabetes patients	DATASUS
Number of people with monitored hypertension per number of hypertension patients	DATASUS
Number of enrolments at elementary school per children between 4-9 years old	INEP
Number of enrolments at middle school per children between 10-14 years old	INEP
Number of enrolments at elementary school for youths and adults in special program per population	INEP
Rate of the distortion age-grade at elementary school plus middle school	INEP
Oil revenue dummy: 1 if municipality received oil rent and 0 otherwise	ANP
Oil price: the annual oil price	ANP
logarithm of per capita municipal GDP	IBGE
logarithm of population/ citizens	DATASUS
logarithm of per capita expenditure on health	DATASUS

ANP: National Regulatory Oil Agency. http://www.anp.gov.br
DATASUS – Health Informatics Department of the Brazilian Ministry of Health. www.datasus.gov.br
INEP – National Institute for Educational Studies and Research "Anísio Teixeira". www.inep.gov.br
IBGE – Brazilian Institute of Geography and Statistics. www.ibge.gov.br

The health and schooling indicators as proxies for human capital are our dependent variables. We split the indicators in two categories, one of efficacy and other to measure the actions of the government in order to improve health and education stock of capital. In the first group we include the indicators that inform about health/schooling efficacy in improving the standard of people´s health/education. For health we consider; 1h) the number of undernourished infants per 10,000 inhabitants, children up to 1 year old, 2h) the infant mortality rate per 10,000 inhabitants also for children up to 1 year old per 10,000 inhabitants, and 3h) incidence of dengue, number of new cases per capita per 10,000 inhabitants. For education, we have 1e) number of enrolments in elementary schools per number of children 4-9 years old, 2e) number of enrolments in middle school per number of children 10-14 years old, and 3e) number of enrolments in primary school in a program for youth and adults per population.

In the second group of health indicators, we deal with health indicators that reflect the actions of the government in order to reach better results. We include the

following health indicators; 4h) number of vaccinated children under 1 year per number of children, 5h) number of vaccinated children under 2 year per number of children, and 6h) number of pre-natal appointments per number of pregnancies. As education indicators, we use 4e) the drop out rate, 5e) the distortion of age-grade rate at elementary plus middle school, and 5e) percentage of teachers in elementary education with higher education.

The DD model allows us to control the treated group of municipalities separately from the non-treated municipalities as a proxy for the counter-factual groups. Thus, first we consider the eligible municipalities as our treated group. The treatment variable w_{it} assumes a 1 value if municipality i is an oil revenue recipient in time t and 0 value if the municipality is not treated, or nor eligible, see equation (1) bellow. Then, we multiply this variable for the oil price p_t at year t in order to have an exogenous variation affecting the health and schooling indicators.

Equation 1 shows the basic structure of our estimated Difference-in-Differences models.

$$I_{it} = c_i + \lambda_t + a w_{it} p_t + \boldsymbol{x}_{it}\boldsymbol{\gamma} + \mu_{it}, \quad (1)$$

where I_{it} is the health/schooling indicator of the municipality i at time t; c_i is the unobserved fixed effect which is removed in the estimates of fixed effect; λ_t is the time effect (year dummies); as w_{it} is the treatment binary variable and p_t is the annual oil price, their crossed value are our interest variable, and vector a measures the effect of oil prices on the treated municipalities; vector $\boldsymbol{x}$ includes all the control variables; and μ_{it} is the idiosyncratic error. The fixed effect controls for the municipal heterogeneity.

To determine the effect of oil revenue on health indicators is necessary to control for the variables that determine the 'stock of health', which are included on the matrix $\boldsymbol{x}$ in equation (1). We include the following municipality variables as the main determinants of health: i) per capita income as a control for standard of living; ii) per capita expenditure on health/education; iii) local population; iv) dummy of year; v) crossed year dummies with state dummies in order to capture the several state and central policies able to affect health and schooling indicators, such as the ones discussed above. A great difficult is to control the estimates for the huge number of policies affecting both health and education as discussed above, including a number of cash transfers programs, federal policies for these two areas, but including all these crossed variables and using fixed effect models we believe to be able to clean our estimates.

Second, to understand the contribution of the top ten recipient municipalities, we set these 19 municipalities (according the classification described in Table 2) as the treated group and all the remaining as the control group (including or not including the small recipients).

4. Results and discussion

Table 1 shows the estimates of the DD models that are calculated by a fixed effects model for the health indicators. Regarding the health indicators that inform about efficacy and are results of government actions to improve health stock of capital, we find positive effects of oil revenues only for the rate of undernourished infants and dengue cases.

The measures taken to improve health by the benefitted local governments are reflected in the estimates of their performance with regard to vaccination programs and the monitoring of ill patients. We find positive effects of the oil revenues only on the vaccinated children, while no effect was found for the rate of pre-natal appointments per pregnancy.

Table 1 – DD for indicators of efficacy and actions taken to improve health – treated group: all oil revenues recipient

VARIABLES	Undernourished children, age<1	Infant Mortality rate, age<2	Number of dengue cases per inhabitant	Vaccinated children, age<1	Vaccinated children, age<2	Pre-natal appointments per pregnancy
	Efficacy indicators			Action indicators		
Oil revenue	-0.0130*	-0.0021	-0.0540***	0.0027***	0.0029***	0.0522
	(0.007)	(0.007)	(0.012)	(0.001)	(0.001)	(0.068)
Observations	48,932	32,991	45,244	56,063	56,031	52,569
R-squared	0.468	0.103	0.329	0.418	0.318	0.002
Number of municipalities	5,396	3,531	4,935	5,451	5,451	5,423

*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses. Variables included; municipal population, GDP per capita, health/schooling expenditure per capita, dummies of year, and crossed dummies of years and states.

For the schooling indicators we get positive effects only for the actions indicators or for the number of enrolments at elementary school and at the primary schooling for youth and adults.

Table 2 – DD for indicators of efficacy and actions taken to improve education– treated group: all oil revenues recipient

VARIABLES	Drop out rate	Distortion age-grade rate	Graduate teachers per number of teachers	Enrolment at elementary school per number of children	Enrolment at middle school per number of children	Enrolment youth and adults by population
	Efficacy indicators			Action indicators		
Oil revenue	-0.0308	0.0061	-0.2399	0.0048**	0.0048**	0.0006***
	(0.054)	(0.059)	(0.177)	(0.002)	(0.002)	(0.000)
Observations	29,397	55,884	35,105	57,892	57,892	52,329
R-squared	0.247	0.785	0.608	0.545	0.555	0.272
Number of municipalities	5,253	5,557	5,262	5,547	5,547	5,545

*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses. Variables included; municipal population, GDP per capita, health/schooling expenditure per capita, dummies of year, and crossed dummies of years and states.

The same estimates of Tables 1 and 2 were found excluding the largest oil revenue recipients that sum 19 municipalities as shown in Tables A1. The results are not statistically different, suggesting their contribution to the indicators' improvement is null.

Table 3 – DD for indicators of efficacy and actions taken to improve health – treated group: all oil revenues recipients: excluding the largest recipients

VARIABLES	Undernourished children, age<1	Infant Mortality rate, age<2	Number of dengue cases per inhabitant	Vaccinated children, age<1	Vaccinated children, age<2	Pre-natal appointments per pregnancy
	Efficacy indicators			Action indicators		
Oil revenue	-0.0128*	-0.0020	-0.0534***	0.0026***	0.0030***	0.0531
	(0.007)	(0.007)	(0.012)	(0.001)	(0.001)	(0.068)
Observations	48,749	32,839	45,060	55,872	55,840	52,391
R-squared	0.468	0.103	0.328	0.417	0.318	0.002
Number of municipalities	5,377	3,515	4,916	5,432	5,432	5,404

*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses. Variables included; municipal population, GDP per capita, health/schooling expenditure per capita, dummies of year, and crossed dummies of years and states.

Table 4 – DD for indicators of efficacy and actions taken to improve education – treated group: all oil revenues recipients: excluding the largest recipients

VARIABLES	Drop out	Distortion age-grade rate	Graduate teachers	Enrolment at elementary school	Enrolment at middle school	Enrolment youth and adults
	Efficacy indicators			Action indicators		
Oil revenue	-0.0356	0.0080	-0.2461	0.0048**	0.0048**	0.0006***
	(0.054)	(0.059)	(0.178)	(0.002)	(0.002)	(0.000)
Observations	29,303	55,716	34,995	57,709	57,709	52,159
R-squared	0.246	0.785	0.608	0.545	0.555	0.272
Number of municipalities	5,236	5,538	5,245	5,528	5,528	5,526

*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses. Variables included; municipal population, GDP per capita, health/schooling expenditure per capita, dummies of year, and crossed dummies of years and states.

Considering only the greatest oil revenues recipients as the relevant treated group, however, we get no effect to the indicators as show in Tables 5 and 6. Where it is possible to see that no effect is observed due to the oil rent, except for drop out rate at elementary school. Thus the results reinforce the absence of contribution of the largest recipient municipalities to improve the human capital indicators.

Table 5 – DD for indicators of efficacy and actions taken to improve health – treated group: top ten recipients

VARIABLES	Undernourished children, age<1	Infant Mortality rate, age<2	Number of dengue cases per inhabitant	Vaccinated children, age<1	Vaccinated children, age<2	Pre-natal appointments per pregnancy
	Efficacy indicators			Action indicators		
Oil revenue	-0.0716	0.0725	0.0224	0.0038	-0.0011	-0.1925
	(0.108)	(0.097)	(0.253)	(0.016)	(0.014)	(0.249)
Observations	48,932	32,991	45,244	56,063	56,031	52,569
R-squared	0.468	0.103	0.328	0.417	0.318	0.002
Number of municipalities	5,396	3,531	4,935	5,451	5,451	5,423

*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses. Variables included; municipal population, GDP per capita, health/schooling expenditure per capita, dummies of year, and crossed dummies of years and states.

Table 6 – DD for indicators of efficacy and actions taken to improve education– treated group: top ten recipients

VARIABLES	Drop out	Distortion age-grade rate	Graduate teachers	Enrolment at elementary school	Enrolment at middle school	Enrolment youth and adults
	Efficacy indicators			Action indicators		
Oil revenue	-1.8856*	-1.1298	5.1349	0.0337	0.0184	0.0060
	(1.064)	(0.996)	(3.617)	(0.047)	(0.046)	(0.004)
Observations	29,397	55,884	35,105	57,892	57,892	52,329
R-squared	0.247	0.785	0.608	0.545	0.554	0.272
Number of municipalities	5,253	5,557	5,262	5,547	5,547	5,545

*** p<0.01, ** p<0.05, * p<0.1, Robust standard errors in parentheses. Variables included; municipal population, GDP per capita, health/schooling expenditure per capita, dummies of year, and crossed dummies of years and states.

One could argue that the lack of contribution of the greatest recipient municipalities is due to having better indicators, since they are receiving large amounts of oil revenues since 1997. Table 7 shows T test for the largest recipients and the remaining, and they have better performance in 50% of the indicators and no difference in 30% of them. But a key question not answered yet is whether these better indicators are good enough for the country and for Brazilian society.

Table 7 – T test for averages: greatest recipient and remaining municipalities

Indicator	Greatest recipients	Remaing municipalities	Difference	(p-value)	Performance in average
Undernourished children, age<1	4.83963	5.18625	-0.34663	0.0001	Better
Infant Mortality rate, age<2	2.77609	3.05024	-0.27415	0.0000	Better
Number of dengue cases per inhabitant	2.10148	1.44861	0.65287	0.0000	Worse
Vaccinated children, age<1	0.94744	0.93646	0.01099	0.0934	Better
Vaccinated children, age<2	0.95246	0.94385	0.00861	0.1368	Not significant
Pre-natal appointments per pregnancy	1.01046	1.22092	-0.21046	0.9174	Not significant
Enrolment at elementary school	1.23574	1.15292	0.08283	0.0001	Better
Enrolment at middle school	1.14189	1.04164	0.10025	0.0000	Better
Enrolment youth and adults	0.03557	0.02116	0.01441	0.0000	Better
Drop out	9.38163	9.2567	0.12493	0.8601	Not significant
Distortion age-grade rate	36.40421	32.07594	4.32827	0.0004	Worse
Graduate teachers	45.82348	48.07921	-2.25573	0.4153	Not significant

Source: Authors

6. Final Remarks

This study performs an evaluation of the effects of oil revenues on the Brazilian municipalities' stock of human capital using several health and schooling indicators as proxies. Since our sample is limited and started only in 2000, and the major part of the eligible municipalities started to be treated before this time, we use the oil price, that is exogenous shocks to these localities, to identify the effects of the oil revenues on the human capital indicators.

The current criterion of oil revenues distribution is very controversial and unequal with a few municipalities receiving the greatest part of the oil rents, although there is a clear rationality about how the localities should use them in order to not penalize the future generations. This can be done investing the oil rent in human and physical capital. Besides that, there is no discussion about the efficiency of the

investment channel set by the new law. Is it an effective connection between oil resources available and sustainable growth? Or new incentives could be design to improve the oil policy.

Our results suggest the Brazilian eligible municipalities are investing in human capital more than the non-eligible, as a consequence of more flexible way to use oil rent can carried by the Oil Law. However, the effects are small and not related to the greatest recipient municipalities. The effects of the oil rent meanwhile are robust. We check the robustness of these results by estimating models excluding the largest recipients and using them as the treated group.

These results are complementary to Postali and Nishijima (2013)' results, because they cover all type of investment allowed as oil rent expenses, respectively human and physical capital. Postali and Nishijima (2013) find just small long run effects of oil rent on physical capital as measured by the household's access to electric wiring, piped water and garbage collection indicators.

Considering the huge amount of oil revenues received in the period by the localities fostered a very shy investment in human capital, the recent decrease in the oil price may result in a weaker sustainable growth. The results suggest the new law has weak enforcement to foster sustainable growth based on the non-renewed resources rent. However, it is not possible to know from our work if the weakness is due to the new law mechanism to use oil rent to promote growth or due to institutional problems, such as lack of enforcement to make the eligible municipalities comply with the law.

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Appendix

Table A1 lists the 10 highest beneficiaries in Brazil from 1997 to 2000, and from 2001 to 2009,[3] as calculated by three different measurement criteria of resource dependence: the revenue of royalties in absolute values (Number 1), the revenue of royalties in per capita values (Number 2) and the ratio between revenues of royalties and the GDP of the municipality (Number 3). Among the ten largest recipients in absolute values, eight are located in the state of Rio de Janeiro, near the Campos Basin, the largest Brazilian oil province. The asymmetry in the distribution of royalties may be illustrated by the fact that these 10 municipalities were granted 29.3% of the total amount of royalties paid to municipalities in the period 1997-2000. Note that Brazil has 5560 municipalities at this time. The ranking of beneficiaries in per capita values is similar to the first, but when their dependence is measured in terms of the royalty-GDP ratio, the 10 highest beneficiaries are another group of municipalities. It should be stressed that the highest recipient municipalities have not changed their relative positions over time.

Table A1 – The top ten recipient municipalities by absolute value of oil revenue (1), by per capita oil revenue (2) and from the ratio between the revenues derived from royalties and the GDP of the Municipality (3)

[3] In 2000, there was a sharp rise in the international oil price that, combined with the floating exchange rate regime that operated in Brazil after 1999, represented a huge increase in the amount of royalties in the savings accounts of some states and municipalities.

State	Municipality	1997-2000	2001-2009
Rio de Janeiro	Armação dos Búzios	1, 2	1,2
Rio de Janeiro	Cabo Frio	1, 2	1
Rio de Janeiro	Campos dos Goytacazes	1	1
Rio de Janeiro	Carapebus	2, 3	2.3
Rio de Janeiro	Casimiro de Abreu	1, 2, 3	1,2,3
Amazonas	Coari	1	1
Rio Grande do Norte	Guamaré	2	2
Rio Grande do Norte	Ielmo Marinho	3	3
São Paulo	Ilhabela	3	3
Rio de Janeiro	Macaé	1, 2, 3	1,2
Rio Grande do Norte	Macau	3	3
Bahia	Madre de Deus	2, 3	2,3
Sergipe	Pirambu	3	
Espírito Santo	Presidente Kennedy	2	2
Rio de Janeiro	Quissamã	1, 2	1,2
Rio de Janeiro	Rio das Ostras	1, 2, 3	1,2,3
Rio de Janeiro	São João da Barra	1	1,2,3
São Paulo	São Sebastião	1	1
Rio de Janeiro	Silva Jardim	3	3

Source: Authors using data supplied by ANP